Practice Session 10 : TOSCA Modelling & Orchestration

Make sure that you have already gone through Lab-09.

In this practice session, you will learn multiple tools/technologies. To make it easier, we will keep the thing as simple as possible.
Before moving to the practice exercises, lets first recall following from the lecture session: *(make sure that you have gone through the lecture 10)*

TOSCA

The TOSCA specification provides a language to describe service components and their relationships using a service topology, and it provides for describing the management procedures that create or modify services using orchestration processes.

Winery

Eclipse Winery is a web-based environment to graphically model TOSCA topologies and plans managing these topologies. The environment includes a type and template management component to offer creation and modification of all elements defined in the TOSCA specification. For more information visit here...https://winery.readthedocs.io/en/latest/#

Ansible

Red Hat Ansible Automation Platform is the IT automation technology that anyone can use. Recall the previous Lecture and Labs where you have already worked with Ansible.

radon-particle

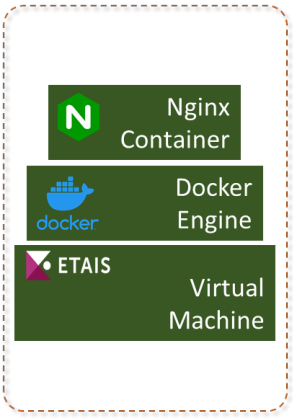
This is the TOSCA definitions repository for the RADON project. The radon-particle github repository contains TOSCA blueprints, reusable definitions and extensions to deploy and manage your TOSCA-based applications.
It provides reusable TOSCA types of application runtimes, computing resources, and FaaS platforms in the form of abstract as well as deployable modeling entities.
For more information on RADON project, visit https://radonframework.eu/, https://radon-h2020.eu/

TOSCA Orchestrator: xOpera

xOpera project includes a set of tools for advanced orchestration with an orchestration tool xOpera orchestrator or shorter opera.

opera aims to be a lightweight orchestrator compliant with OASIS TOSCA and the current compliance is with the TOSCA Simple Profile in YAML v1.3.

A simple application



We will model the above application using Winery and deploy the application using xOpera.
In this simple application, we will deploy an nginx web server on docker engine. The docker engine will be installed in a centos VM.

The required node types are already created for this lab session.

Prerequisites

- Make sure that two VMs are up and accessible
  - **k8s-Controller :** This will be used for modelling the above application. We will also install the orchestrator (e.g. xOpera) on this VM.
  - **k8s-master** : The above modelled application will be deployed on this VM.

- Make sure that you can login to the **k8s-master** VM (over ssh) from the **k8s-controller** VM.
- On **k8s-controller** VM, make sure that the latest version of the pip package is installed. You may follow the below commands if you need to do so.
  - `sudo yum update`
  - `python -m ensurepip --upgrade` to install pip
  - `python -m pip install --upgrade pip` to upgrade pip

1. Winery Installation and Configuration

- Login to https://Gitlab.cs.ut.ee and fork https://gitlab.cs.ut.ee/devops22fallpub/radon-particles repository to your subgroup

https://gitlab.cs.ut.ee/groups/devops2022-fall/students/devops2022fall-<lastname>-<studycode>.
    - While forking use the project name Lab-10-radon-particles
- Using Terminal, login to your **k8s-controller** VM
- Go to the home directory. Clone the above forked repository.
    - The forked repository URL may look like below (if you have not changed the project slug while forking) https://gitlab.cs.ut.ee/groups/devops2022-fall/students/devops2022fall-<lastname>-<studycode>/Lab-10-radon-particles
- **Change directory** to Lab-10-radon-particles
- Install Winery in a docker container using the following command:

```
docker run -p 8081:8080 \
  -d --name lab-10-tosca \
  -e PUBLIC_HOSTNAME=localhost \
  -e WINERY_FEATURE_RADON=true \
  -e WINERY_REPOSITORY_PROVIDER=yaml \
  -v $PWD:/var/repository \
  -u `id -u` \
  opentosca/radon-gmt
```

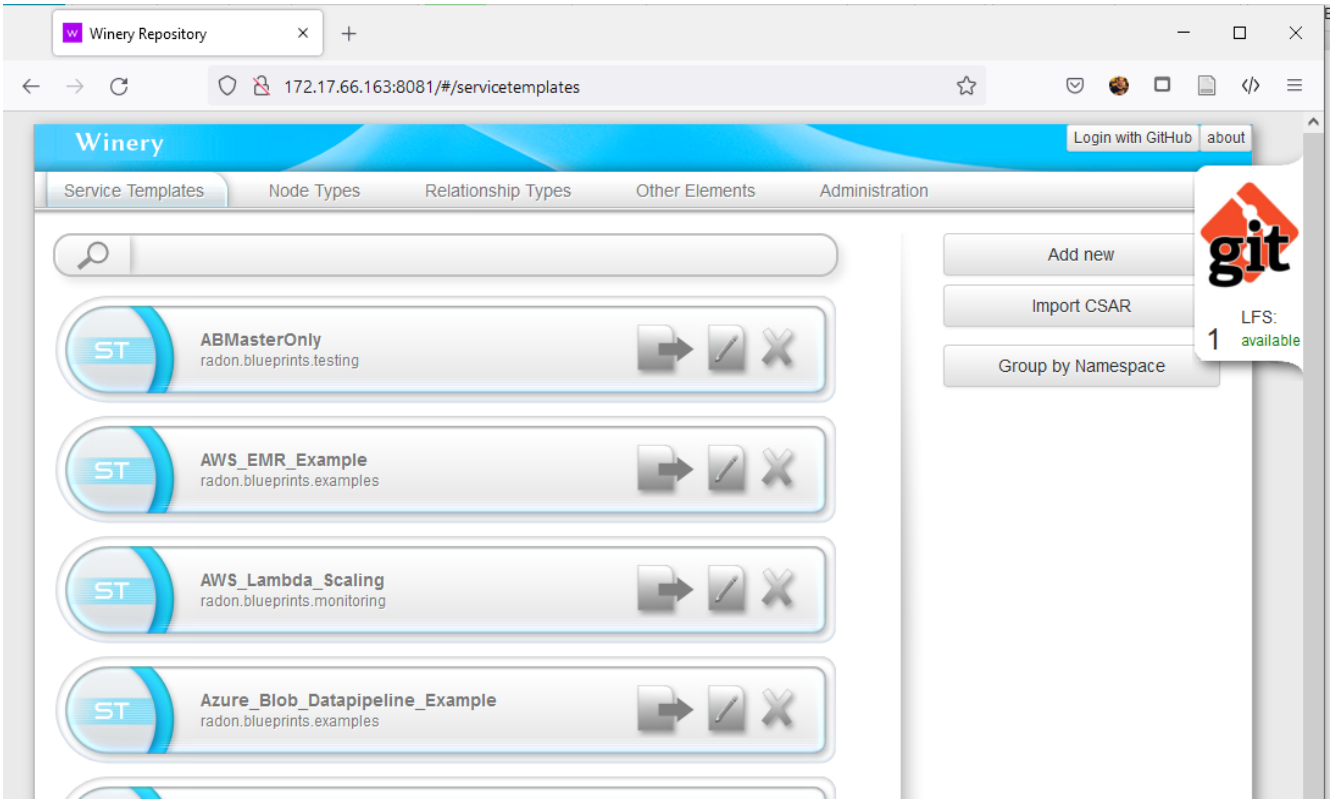
- You can issue `docker ps` command to see if the container is running
- The above Lab-10-radon-particles repository is now mounted to /var/repository directory inside the container

- References :
    - Winery Github repo: https://github.com/eclipse/winery
    - Winery documentation: https://winery.readthedocs.io/en/latest/#
    - Official radon particle repo: https://github.com/radon-h2020/radon-particles

2. Accessing Winery

To access the web UI of winery container

- Goto your web browser and visit http://<Controller_VM_EXTERNAL_IP>:8081
- You should be able to get the homepage *similar* to below:



- Go through the tabs, such as `Service Templates`, `Node Types`, etc.

Eclipse Winery starts from the `Service Template` view. In this view, users can create new TOSCA service templates or maintain existing ones. A service template refers to an application template.

3. Installation of xOpera

xOpera is distributed as a Python package that is regularly published on PyPI. So the simplest way to test opera is to install it into a virtual environment.

- Using terminal, login to your **k8s-controller** VM
- Update theCentOS: `sudo yum update`
- Create and change directory to a new opera directory : `mkdir $HOME/opera && cd $HOME/opera`
- Create a virtual environment: `python -m venv .venv`
- Activate the virtual environment: `. .venv/bin/activate`
- Upgrade pip to its recent version : `pip install --upgrade pip`
- Now it is the time to install opera: `pip install opera==0.6.8`

- Check the installation by only issuing `opera` command

```
(.venv) [centos@k8s-controller-chinmaya opera]$ opera
error: the following arguments are required: command
usage: opera [-h] [-s {bash,zsh,tcsh}] [--version] {deploy,diff,info,notify,outputs,package,undeploy,unpackage,update,validate} ...

opera orchestrator

positional arguments:
  {deploy,diff,info,notify,outputs,package,undeploy,unpackage,update,validate}
    deploy              Deploy TOSCA service template or CSAR
    diff                Compare TOSCA service template to the one from the opera project storage and print out their differences
    info                Show information about the current project
    notify              Notify the orchestrator about changes after deployment and run triggers defined in TOSCA policies
    outputs             Retrieve deployment outputs (from TOSCA service template)
    package             Package service template and all accompanying files into a CSAR
    undeploy            Undeploy TOSCA service template or CSAR
    unpackage           Unpackage TOSCA CSAR to a specified location
    update              Update the deployed TOSCA service template and redeploy it according to the discovered template diff
    validate            Validate TOSCA service template or CSAR

optional arguments:
  -h, --help            show this help message and exit
  -s {bash,zsh,tcsh}, --shell-completion {bash,zsh,tcsh}
                        Generate tab completion script for your shell (default: None)
  --version, -v         Get current opera package version (default: None)
```

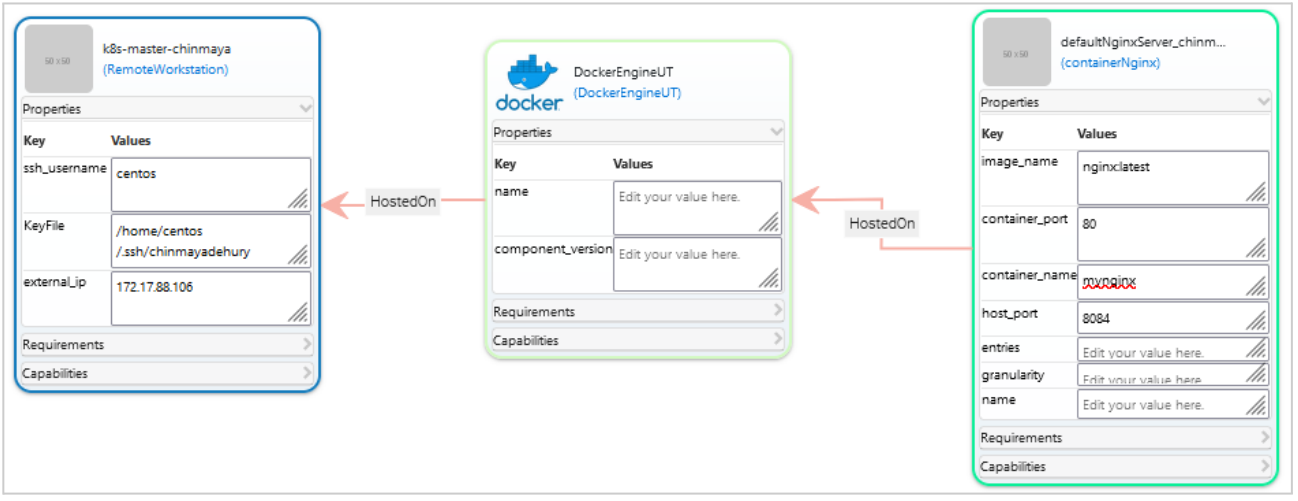
References :
- xOpera Github repo: https://github.com/xlab-si/xopera-opera
- xOpera documentation is available here: https://xlab-si.github.io/xopera-docs/index.html
- Cli command references: https://xlab-si.github.io/xopera-docs/cli.html#cli-commands-reference

Note: Remember that opera requires python 3 and a virtual environment. Before you issue any opera command, make sure that you have activated the virtual environment.

- [ ] `cd $HOME/opera`
- [ ] `. .venv/bin/activate`
- [ ] `opera`

4. Go through your application.

Let's first see the application. At the end of the modelling, your application *may* look like below:



At this point, you need to understand the essential properties of each node.

1. RemoteWorkstation:

The purpose here is to add the **k8s-master** VM this to the Ansible inventory list including the VM's External IP, login username and the ssh key file

Property name	Description
`ssh_username`	This is similar to the username that you use to login to the VM through `ssh`. For centos VM this should be `centos`.
`KeyFile`	This is the path to the ssh key file in the **k8s-controller** VM. In this example, I have kept my ssh key file (`chinmayadehury`) in the **k8s-controller** VM inside the /home/centos/.ssh directory.
`external_ip`	This is the external IP of the **k8s-master** VM where the application will be deployed.

Now Ansible will use the above information to login to your **k8s-master** VM.

2. DockerEngineUT:

The purpose of this node is to install docker engine and other related libraries for centos OS.
Currently, this node has no properties to modify.

3. ContainerNginx:

The purpose here is to create a container atop the docker engine in **k8s-master** VM. For this, the essential properties are:

Property name	Description
`container_name`	This is the name of the container.
`image_name`	This is the docker image name. The name should be given in `<image_name>:[tag]` format (e.g. nginx:1.13). Make sure that the image is present in docker hub.
`host_port`	These two values are used to map/bind the port number of **k8s-master** VM and the container.
`container_port`	

Note:

- The ContainerNginx node (which is in its development phase) can also be used to create any other container.

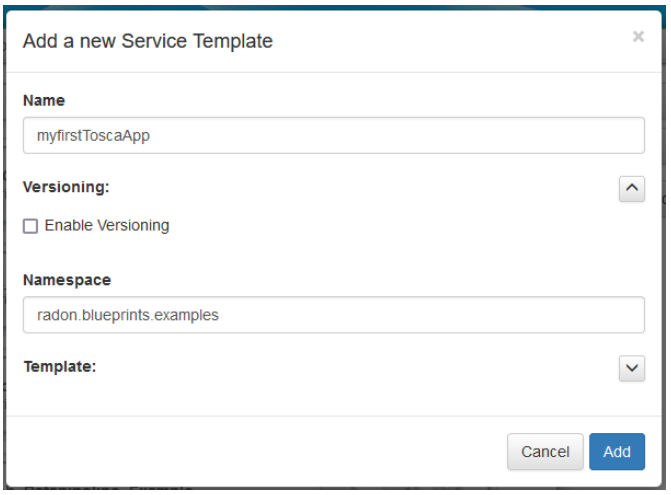
5. Model and Orchestrate the application.

In the above application, we will install a docker engine including all the related libraries on **k8s-master** VM. Once the docker engine is installed and started, we will create a nginx web server inside a container.
Make sure that you are in the **k8s-controller** VM. It is assumed that you can login to **k8s-master** VM.

With the above information, let's model the application.

STEP-1: Creating the service template

- Access the winery UI: http://<k8s-controller_external_IP>:8081
- Select the `Service Templates` tab.
- Click on `Add New` button to create a new service template
- Enter the name `myfirstToscaApp`
- Disable the `Versioning`
- Give `radon.blueprints.examples` as the `Namespace`
- Now the form/dialog box should look like below

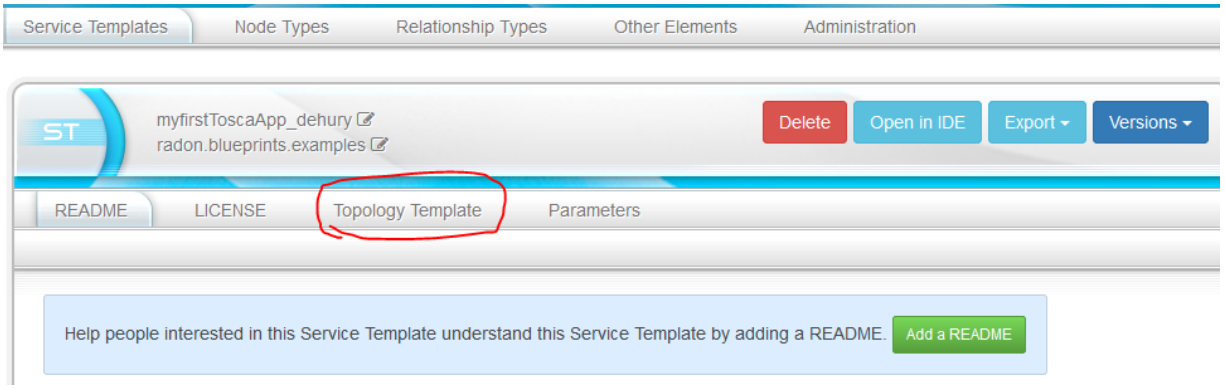


- Now Click on `Add` button

STEP-2: Accessing topology modeller

Now you are inside the newly created service template or the application and ready to add the required nodes.

- Click on `Topology Template -> Open Editor` to access the topology modeller window, as shown below:

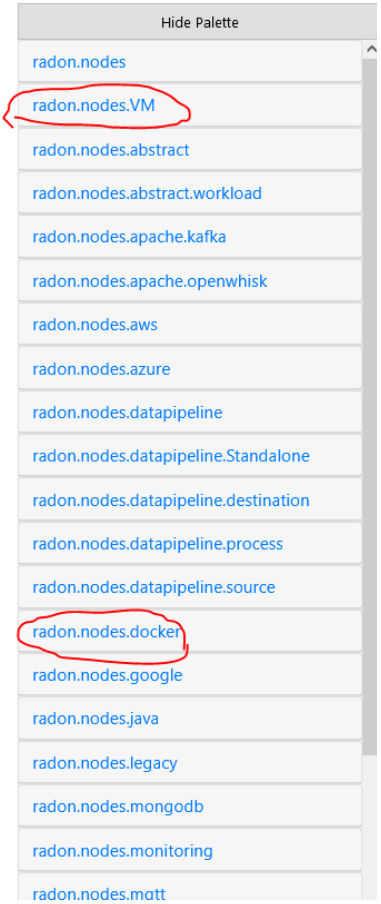


- This will open a new winery graphical modelling window.
- Go through the palette and get an overview of a list of node types available.

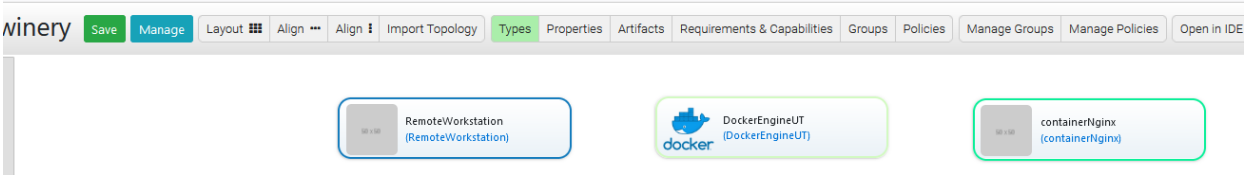
STEP-3: Adding required nodes

Now, you are ready to model your application by adding the required nodes (a node simply represents an application component).

- First add the following required nodes by dragging the nodetypes to the canvas:
  - RemoteWorkstation present under `radon.nodes.VM`
  - DockerEngineUT available under `radon.nodes.docker`
  - containerNginx available under `radon.nodes.docker`
- You can get this nodetype from left side palette, as shown below:



- After adding the nodes, the canvas may look like below:

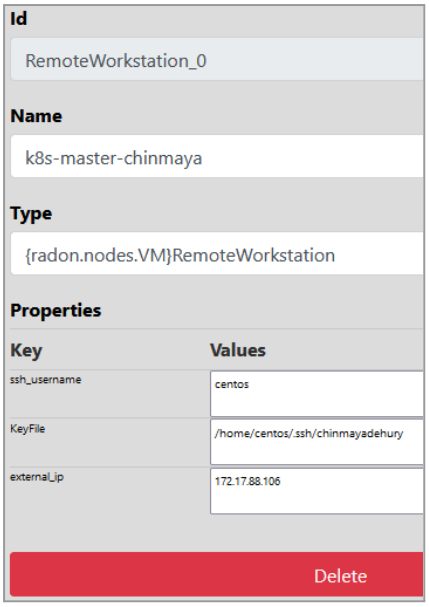


- Now you need to provide the properties and establish the relationships among them.

STEP-4: Assigning values to properties

- Click on `Properties` and `Requirement & Capabilities` button, as shown below:

- Select RemoteWorkstation node and you will see the meta information and the list of properties in the right side of the window.
- Edit the `Name` of the node and provide the following properties value, as shown in below figure:
    - `ssh_username`: This should be `centos`.
    - `KeyFile`: In the prerequisites step, I have already kept my ssh key file in /home/centos/.ssh directory (in **k8s-controller** VM). Update this value according to your environment.
    - `external_ip`: This is the external ip of the **k8s-master** VM. You should update this according to your **k8s-master** VM.



- Now repeat the above step for other nodes.
- For DockerEngineUT node:
  - `name`: you may leave to default
  - `properties`: nothing to update here
- For containerNginx node:
  - `name`: give some name (e.g. `defaultNginxServer_chinmaya`)
  - `image_name:  nginx:1.13`
  - `container_port:  "80"`
  - `container_name:` give some name (e.g. `mynginxserver`)
  - `host_port:  "8082"`

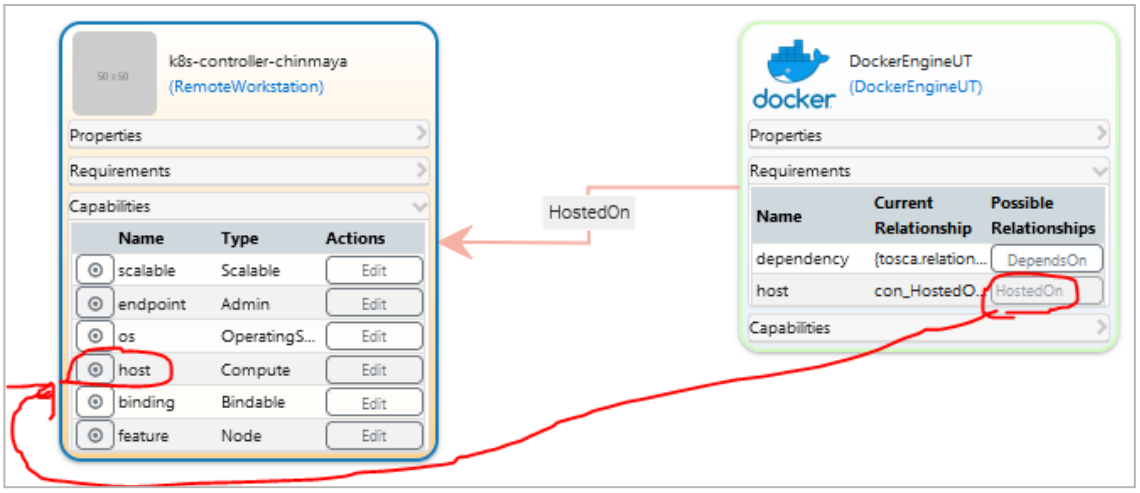
Note:

- Remember to use (") in `container_port` and `host_port` values
- You Use your name not "`chinmaya`" while naming the containerNginx node

STEP-5: Connecting all the nodes

In this step, we will establish the relationships among all the added nodes.

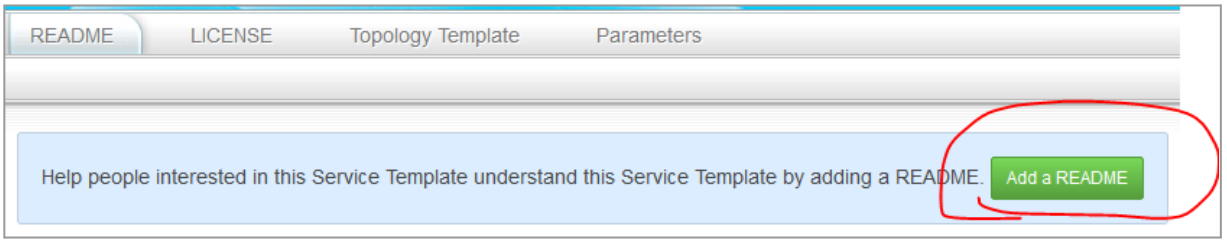
- Click on the `Capabilities` of `RemoteWorkstation` node
  - Find `host` capability name
- Click on the Requirements of DockerEngineUT node
  - Find `HostedOn` relationship type
- Connect `HostedOn` requirement to `host` capability by click-n-drag, as shown below:



- Similarly connect containerNginx node to DockerEngineUT node.
- Click on `Requirements` of containerNginx node
  - Find `HostedOn` relationship
- Click on `Capabilities` of DockerEngineUT node
  - Find `host` capability name
- Establish the connection from `HostedOn` requirement to `host` capability.
- Now cross-verify the properties and click on `Save` button..
- Once saved, Close the window.

STEP-6: Export the service template (or your TOSCA-based Application)

Add a `README` with your content. You can describe the application in your own words in a few sentences.



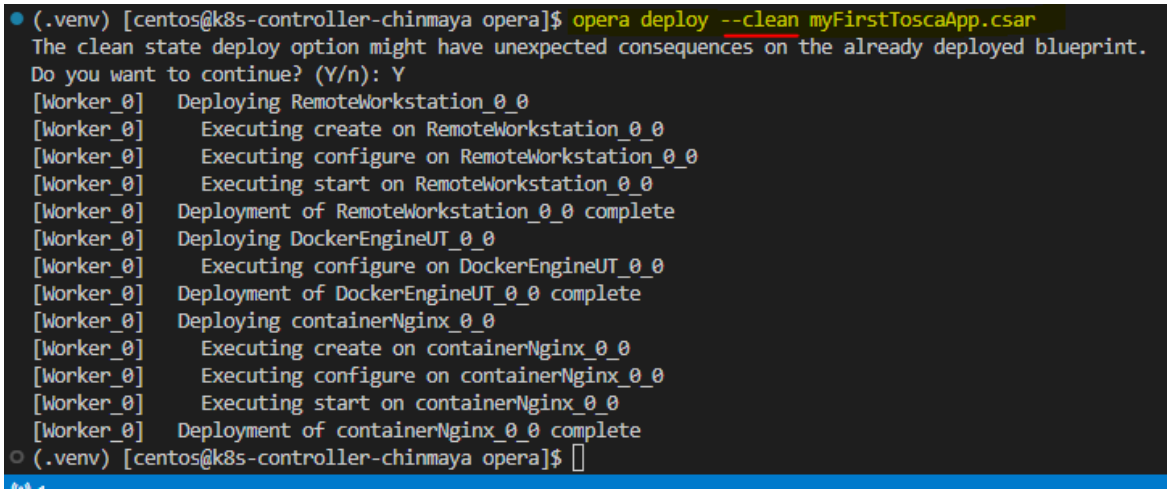
Now lets export the application by clicking on `Export -> Download` option.

This will download the whole application blueprint in CSAR format, i.e. `myfirstToscaApp.csar`. A CSAR file is a ZIP file, it can be extracted, edited by hand and re-packaged.
Optional : Extract the CSAR package and go through all the internal files and folders. Once you unzip, you can start looking at

`_definitions/radonblueprints__myfirstToscaApp.tosca` file. You can see all the nodes and their corresponding properties values.

STEP-7: Orchestrate the application

- Upload the csar file (the zipped package) to the **k8s-controller** VM (inside /home/centos/opera).
- Login to the **k8s-controller** VM
- Change directory to /home/centos/opera
- Activate the virtual environment if it is not activated. : `. .venv/bin/activate`
- Now deploy TOSCA application: `opera deploy myfirstToscaApp.csar`
- **Screenshot**: Take the screen shot of the output (similar to the one given below) and save the image file with the name **`Screenshot-5-7-OperaDeploy.jpg`**. The screenshot should also include the command that you have entered.



- Once all the nodes are deployed you may verify if the nginx web server is installed and accessible.
- For this visit http://<k8s-master_VM_external_IP>:8082 and you should be able to see the default nginx web server page.
    - **Screenshot**: Take the screenshot of the entire default nginx web server page including the browser's address bar. **IP** and **port number** of the nginx server should be visible in the screenshot. Save the screenshot with the name **`Screenshot-5-7-nginx-page.jpg`**.
- Login to **k8s-master** VM.
    - Execute **docker ps -a** command.
    - **Screenshot**: Take the screenshot of output of above **docker ps -a** command. Here, it is expected that the nginx container is up and running. The following information should be visible in the screenshot:
        - IMAGE
        - COMMAND
        - CREATED

        - STATUS
        - PORTS
        - NAMES

    Save the screenshot with the name **`Screenshot-5-7-nginx-container.jpg`**.

6. Deliverable: Commit and push the changes

Here, you will push the changes that are made to the cloned https://gitlab.cs.ut.ee/groups/devops2022-fall/students/devops2022fall-<lastname>-<studycode>/Lab-10-radon-particles repository.

For this you may follow below steps:

- Using Terminal, login to your **k8s-controller** VM
- **Change directory** to Lab-10-radon-particles
- Create a directory Deliverable in the project's root directory
- Keep the following inside Deliverable directory
    - **`Screenshot-5-7-OperaDeploy.jpg`**
    - **`Screenshot-5-7-nginx-page.jpg`**
    - **`Screenshot-5-7-nginx-container.jpg`**
    - **`myfirstToscaApp.csar`**, `this file you have downloaded in Step 5.6`
- Now commit and push the changes to your https://gitlab.cs.ut.ee/groups/devops2022-fall/students/devops2022fall-<lastname>-<studycode>/Lab-10-radon-particles repository with the commit message "Uploading deliverables".

Submission:

1. `Zip the` Deliverable directory `only which includes three screenshots and one .csar file and Upload the zip file to the course wiki page.`
2. `You may` **`Stop`** `the Virtual Machines and you can start using the same in the next` **`practice session.`**

`Don't delete your VMs`

7. Bonus task : Develop your own TOSCA node type

- This task is beyond only use of existing node types. Here you basically need to create a new nodetype similar to `containerNginx` node type.

- Before going to develop your own node type, first explore the `Node Types` tab from the winery UI. In the search box, let's enter `containerNginx` and select the `containerNginx` node type.
- Once you click on the `containerNginx` , you will see several tabs, such as `Property Definitions`, `Attribute Definitions`, `Capability Definitions`, `Requirement Definitions`, `Inheritance`, `Artifacts`, `Interfaces` etc....

Go through those tabs, especially the tabs mentioned above.
Once finished, you can create your own node type with following properties and attributes:

Nodetype name: `containerGeneric`

Namespace: `radon.nodes.docker`

Disable `Versioning`

`Properties, attributes, inheritance, artifacts, interfaces` : similar to `containerNginx`

You are welcome to ask PI (Chinmaya Dehury) in any of the groups' time for more explanation and guide to do bonus tasks. But make sure that you have finished the above exercises.

Submission of bonus task:

- Similar to above Deliverable section commit and push the changes with the commit message "adding bonus task"
- Demonstrate that the newly developed node type is working. For this you may update the same service template created before.
    - For the demonstration purpose, contact PI.